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THE CHALCIS-FLY IN ALFALFA SEED.

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INTRODUCTION.

The clover-seed chalcis-fly [1] (fig. 1), which is generally termed the alfalfa-seed chalcis-fly by alfalfa-seed growers, has been increasing

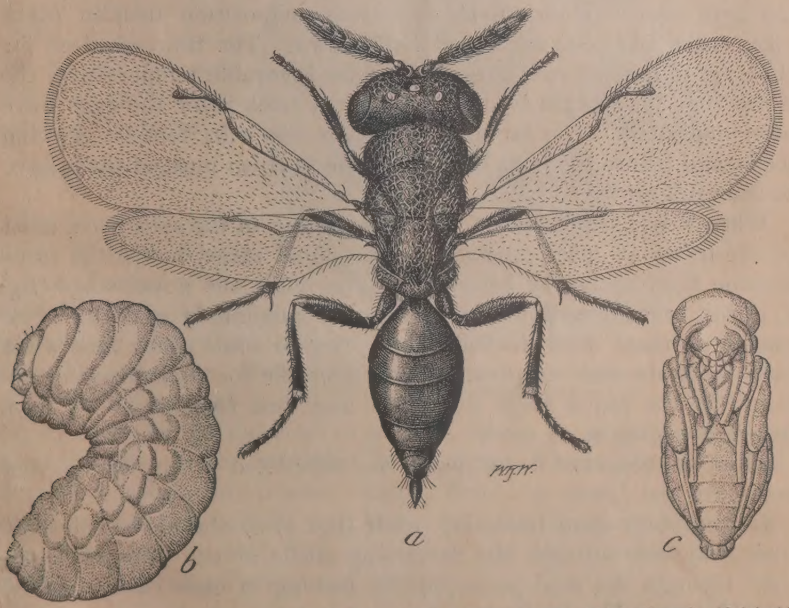

FIG. 1.—The alfalfa-seed, or clover-seed, chalcis-fly: *a*, Adult; *b*, larva; *c*, pupa. Much enlarged. (Original.)

so rapidly that its destructive work is now causing a large annual loss, and in some sections even threatening the production of alfalfa seed.

[1] Scientific name, *Bruchophagus funebris* How.

NOTE.—This bulletin furnishes a general knowledge of the chalcis-fly, an insect injurious to alfalfa seed, and contains several practical methods for its control.

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In the fall of 1912 an investigation was started with a view to determining some practical method of checking this pest. Much of this work is still in an experimental stage, but certain practices are at hand whereby the grower of alfalfa seed may reduce the numbers of this insect in his fields and without doubt profit largely by the results.

The different sections in which investigations have been conducted present in themselves many local problems which must necessarily be omitted in this brief preliminary account of an insect which is so widely distributed and so destructive. Nevertheless this bulletin will serve to give the alfalfa-seed grower a general knowledge of the chalcis-fly, together with such information as will direct him in adopting measures for reducing the large annual loss due to its work.

DEVELOPMENT AND HABITS.

The eggs are very small; in fact, they are invisible to the naked eye, and are deposited through the soft green seed pods directly into the soft seeds. Under field conditions oviposition usually takes place when the pods are about half grown. The time required for the eggs to hatch varies greatly. Under favorable temperatures the larvæ (fig. 1, *b*) begin feeding in about a week after the eggs have been deposited. The larvæ feed within the soft, tender, growing seeds, and before the pods have had time to ripen most of them have become full grown.

When there is sufficient moisture remaining in the seed pods, most of the larvæ at once transform to the pupal stage, but if the seeds become thoroughly dry before the larvæ enter the pupal stage (fig. 1, *c*) this transformation may be delayed indefinitely and the larvæ remain dormant until the following spring or some other time when both moisture and temperature are favorable for their transformation. In the pupal stage the insect may rest from 10 to 40 days before emerging as an adult.

All of the stages of development are completed within the infested seeds.

Immediately upon becoming adult (fig. 1, *a*) the chalcis-flies eat their way out through the remaining shells of the infested seeds, then through the seed pods (fig. 3), leaving in each case a hollow seed (fig. 2). The adults may be seen in great numbers flying over alfalfa-seed shocks and swarming over the sickle bar when the crop is being cut. They are frequently confused with gnats.

The chalcis-flies are most active in hot weather, but seek the shade in the heat of the day. They visit the alfalfa blossoms apparently to secure food, and in moderate weather live to be several weeks old.

FLIGHT.

The adults of the chalcis-fly are very active in their flight and without doubt are carried long distances by the strong summer winds. They have been observed in great numbers carried by the winds on a hot summer day, alighting on almost any object in their course.

HIBERNATION.

The chalcis-fly hibernates in the larval stage within alfalfa seeds. By far the greater number may be found in the seeds on neglected fields (fig. 9) and along fence lines and ditch banks (figs. 6, 7). A great many seed pods may be found on the surface of fields from which the seed crops have been removed, and especially along the check ridges where alfalfa frequently remains standing. Screenings around the alfalfa straw stacks (fig. 8) and the seed of bur clover[1] conceal many of the larvæ.

FIG. 2.—Alfalfa seeds which have been hollowed out by the larvæ and from which the adult chalcis-flies have emerged. (Original.)

DISTRIBUTION.

In Circular 69,[2] Mr. F. M. Webster shows the distribution of the alfalfa-seed chalcis as probably covering the entire United States. The writer has personally observed its destructive work in clover or alfalfa seeds from the Gulf coast to the northern limits of the United States, as well as in the southwestern States. Injury from this insect has been observed in cultivated alfalfa seed imported from Germany, Turkestan, and Chile, and in both the cultivated and uncultivated varieties of alfalfa seed from Turkey and Siberia.

CHARACTER OF INJURY.

The clover-seed chalcis-fly confines its work entirely to the seeds of clover, bur clover,[1] and alfalfa. Its destructive work results in the hollowing out of large portions of the seeds while still soft and green

[1] Scientific name, *Medicago hispida*.

[2] Webster, F. M. Some insects affecting the production of red clover seed. U. S. Dept. Agr., Bur. Ent. Circ. 69, pp. 9, figs. 8, Apr. 12, 1906.

and growing in the fields. (See fig. 2.) The percentage of aborted and worthless seeds is increased by infestation before they are large enough to supply the growing larvæ with food. In such cases both the larvæ and seeds are prematurely destroyed.

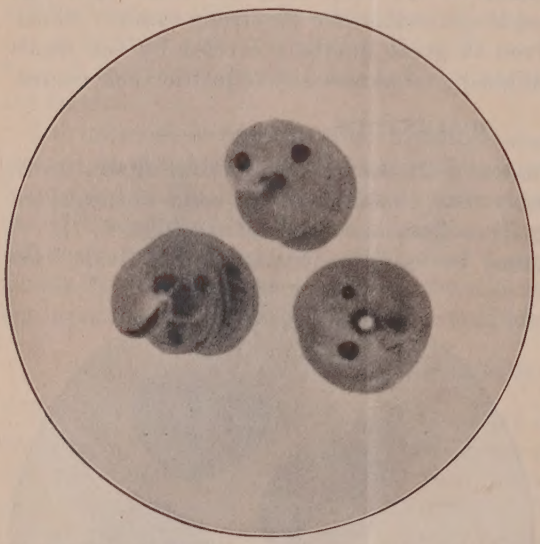

FIG. 3.—Alfalfa seed pods, showing the openings made by the adult chalcis-flies as each escaped from a seed within. (Original.)

When the adults of the chalcis-fly emerge normally from the alfalfa seeds they leave nothing but the hollow shell (fig. 2), with the opening from which the adult has escaped near one end. A similar opening is left in the seed pods, directly over that in the seed (fig. 3). The infested seeds which still contain the living larvæ of the insect may be recognized by their abnormal shape (fig. 4), and usually by the dull brown color. Some of the infested seeds, however, retain their natural color, but they always lack the glossy appearance of normal seeds.

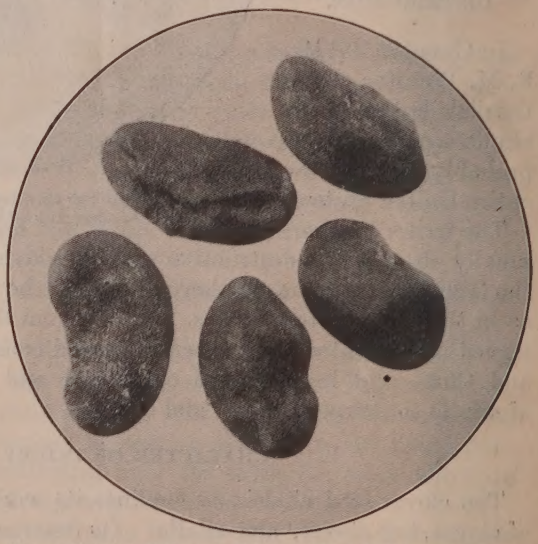

FIG. 4.—Infested alfalfa seeds which contained the hibernating larvæ of the chalcis-fly. (Original.)

EXTENT OF INJURY.

The extent to which alfalfa seed is damaged by the chalcis-fly is not generally apparent, owing to the minuteness of the insect and because its destructive work is accomplished within the growing seeds. The alfalfa-seed grower can only estimate the percentage of his crop destroyed by opening a large number of the seed pods and observing the infested seeds. Even then he can not

estimate with any degree of accuracy without the aid of a good microscope.

Alfalfa seed pods collected in different localities from both early and late crops show that seed crops maturing late in the season suffer a greater loss from this insect than those maturing early. Observations showed that the early emerging adults are crowded to the first seed pods in large numbers, resulting in a heavy infestation. These first pods are, however, nearly always found on the isolated plants growing on fence lines and ditch banks.

In localities where bur clover is abundant the pods of these plants receive the early infestation.

When the alfalfa pods develop in large numbers on the early seed fields there is apparently a decrease in the percentage of in-

FIG. 5.—A severely infested alfalfa seed field which had been abandoned. Infested pods cover the ground, where they offer favorable conditions for the hibernation of the chalcis-fly. (Original.)

fested seed, and from this time on a gradually increased infestation follows until the close of the season.

Seed pods collected in different localities and subjected to examination with a microscope show that the chalcis-fly destroys from 10 to 30 per cent of the seeds in the early crops and from 20 to 70 per cent of the seeds in the late crops. Several samples were examined which showed that 85 per cent of the seed had been destroyed by this insect.

The actual loss per acre depends upon the market value of the seed and upon the yield per acre of the crop. The loss has been observed on different farms to vary from $5 to $60 per acre. There are still many seed-growing districts which have not been visited in connection with this study and where little is known concerning the work of the chalcis-fly.

CONTROL METHODS.

Methods for the practical control of this insect pest are being conducted; and while they are still in an experimental stage, the following pages give fundamental practices which should be carefully carried out by every alfalfa-seed grower to obtain immediate results.

HARVESTING SEVERELY INFESTED CROPS.

An alfalfa field is frequently found with such a severe infestation by chalcis-flies that the grower considers it of insufficient value to be harvested and simply drives in a herd of cows to pasture the crop. (See fig. 5.) With regard to the control of the chalcis-fly for the protection of future seed production, this is a costly mistake.

FIG. 6.—This ditch bank, 3½ rods wide, with its neglected alfalfa, was a place of breeding and hibernation for the chalcis fly—a source sufficient for the infestation of surrounding fields. (Original.)

Observations show that many of the pods burst open, while others are trampled to the ground. Here great numbers of infested seeds offer favorable conditions for the hibernation of the chalcis-fly larvæ. These, as mature flies, will infest the seed crop the following spring. Under such circumstances the crop should be mowed, removed from the field, and stacked. It may then be used as rough fodder; and if the remaining straw is burned in early spring, the hibernating larvæ will be destroyed.

CLEANING FENCE LINES AND DITCH BANKS.

The following facts emphasize the importance of cutting the alfalfa along ditch banks (figs. 6, 7) and fence lines, as well as in the fields.

1. The earliest seed pods are found to develop on the isolated and vigorous growing plants found in such places.

2. The earliest pods have an especially large percentage of the seeds infested with chalcis-fly larvæ.

3. The chalcis-fly larvæ are able to pass completely through the first generation in the earliest pods before the regular seed fields are sufficiently advanced for oviposition.

This cutting should be done with the harvesting of each hay crop, before the seed crop is grown.

It is sometimes necessary to have two or more irrigation ditches running parallel, making it impracticable to cut the alfalfa between them. In such cases it is economy to fence the ditches and use this

FIG. 7.—The rank growth of dry alfalfa shown on this ditch bank was loaded with infested seed pods in which a multitude of chalcis-fly larvæ were hibernating. (Original.)

land as a small summer pasture, thus preventing the development of alfalfa seed pods and the chalcis-flies.

WINTER CULTIVATION.

In the process of harvesting the seed crop many pods containing infested seeds fall to the ground. Here they remain until the following spring when the hibernating insects emerge. A thorough cultivation with an alfalfa cultivator, at some time late in the fall or in early winter, will sufficiently cover such pods and will prevent the emergence of most of the adults when the warm spring weather arrives.

DESTROYING THE SCREENINGS.

After the alfalfa is thrashed the great mass of screenings which is left (see fig. 8) frequently contains large numbers of seeds infested with hibernating larvæ. If the chaff, together with the screenings, is placed in a compost pile for three or four months, so that it will

become heated and decay, most of the insect life will be destroyed. Unless it is possible to treat the screenings in this manner they should be burned before the growing season opens in the spring.

BURNING FENCE LINES AND CHECK RIDGES.

Many of the alfalfa seed pods along check ridges and fence lines may be destroyed by burning off the weeds and alfalfa, as is shown in figure 9. This should be done either in the fall or early spring.

PLANTING CLEAN SEEDS.

In purchasing alfalfa seed, farmers should insist upon having seed which has been well cleaned after thrashing and should never plant

FIG. 8.—An alfalfa straw stack, showing the ground covered with screenings in which many chalcis-fly larvæ are hibernating. (Original.)

the uncleaned product in new fields. In many localities much of the seed is sold both by farmers and by local dealers without first having been cleaned. The product of such seed when harvested from the late crops frequently contains a 10 to 15 per cent infestation of hibernating chalcis-fly larvæ. The planting of this uncleaned seed frequently gives the chalcis-fly a start in the new field, as well as resulting in a poor stand.

CUTTING THE SEED CROP.

It is not an uncommon practice for the farmer to allow the seed crop to remain on the fields an excessive period in order that more of the green pods may develop. In such fields on the same plant are found ripe pods bursting open, as well as fully developed, half-grown, and newly forming pods.

Observations show that many of the chalcis-flies infesting the earlier or first pods have had sufficient time to complete their life develop-

ment, emerge from the seeds, and deposit their eggs into the green pods growing on the same plant upon which they themselves were fostered.

In view of this the seed crop should be so handled that the setting of pods will be as uniform as possible, and the crop should then be harvested as soon as the larger number of the pods are ripe.

STACKING THE SEED CROP.

It has been demonstrated that great numbers of chalcis-flies emerge from the seed pods at about the time the pods ripen, and continue to emerge indefinitely. In midsummer most of them, however, emerge

FIG. 9.—An alfalfa seed field with check ridges and fence lines burned over to destroy the hibernating larvæ of the chalcis-fly. (Original.)

within three or four weeks after the crop is harvested. Where later seed crops are grown, it is therefore advisable to stack the early crops as soon as possible, thus preventing the free emergence offered by leaving the crop in shocks on the field.

DESTROYING BUR CLOVER.

In some localities bur clover grows abundantly and matures its seed pods in early spring. The chalcis-flies thus have already completed the development of an entire generation in the seeds of these plants before the alfalfa seed pods have developed in the fields. Under such conditions it would be well to destroy the bur clover pods by burning the fence lines in the spring. This can frequently be done after the plants mature and before the alfalfa seed crop comes on.

CLEANING THE SEEDS.

Some of the alfalfa seed-growing districts have organizations among the seed growers with officers having complete charge of cleaning and marketing the seeds for the growers. The product handled

through these organizations is, for the most part, well cleaned, so that nearly all of the infested seeds are removed before marketing. (See fig. 10.) When done on a large scale the cost of cleaning the seed is about 40 cents per 100 pounds. In addition to removing the infested alfalfa seeds, this process removes the weed seeds, and the product will then command the highest market prices. Where it is

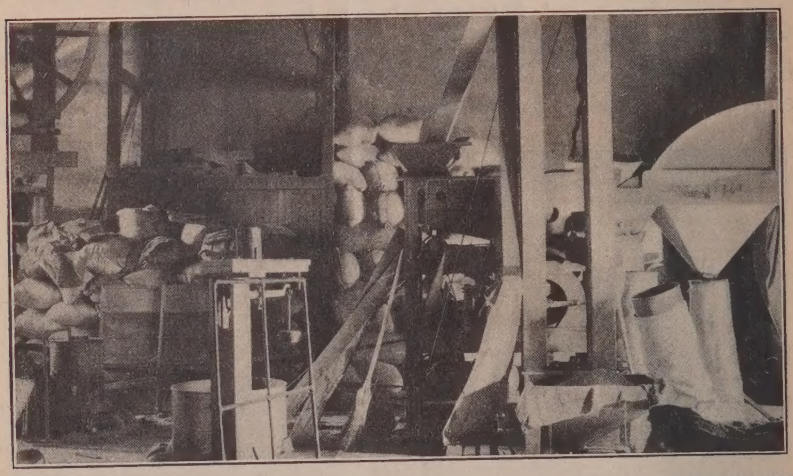

FIG. 10.—An interior view of an alfalfa seed-cleaning plant, where the infested seeds, together with weed seeds, are removed before the product is sold for planting. (Original).

necessary to do the cleaning on the farm, good results may be secured by using the proper sieves in a small fanning mill.

NECESSITY OF ORGANIZED EFFORTS.

The habits of this insect, together with the general practices of alfalfa-seed growers, make it necessary for the growers of each district to cooperate in an effort to control this destructive seed pest. While it is important that each farmer do all in his power to reduce the abundance of this insect on his own farm, the efforts of an individual are greatly hampered by the negligent habits of a neighbor. The rapid distribution from breeding centers of the chalcis-flies and the short minimum period required for the development of the adults render organized action necessary.

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